

shock, in that plasma must be given cautiously and the head-down position may embarrass respiration.

The immediate danger is over after 48 hours, when the pulmonary lesions may be complicated by pneumonia; sulfonamides should be given as one would for lobar pneumonia.

If a wound necessitates operation under anesthesia in a patient injured by a pulmonary irritant, inhalation and spinal methods should be replaced by field block or local anesthesia.

#### 6. Vesicants:

The main action of the mustard "gases" and of Lewisite is the production of severe inflammation of skin and eyes. Prevention of this effect by energetic first aid or, better, self help is of utmost importance.

Since one has only a few minutes to remove or neutralize these agents, *speed* in carrying out a predetermined plan is essential. Remove the victim from the contaminated area and his clothes from him. If exposure to the liquid form of the mustard or Lewisite has occurred within five minutes, wash the eyes thoroughly with freshly prepared 2 per cent solution of sodium bicarbonate (heaping tablespoonful per quart of *warm* water) if available at once; tap water is preferable in case of delay. In the event of exposure to vapor, or to liquid vesicant prior to five minutes, lavage of the eyes is useless and may even be dangerous. Next, blot without rubbing any excess vesicant from the skin, disposing of the used absorbent cotton or toilet tissue to prevent other burns.

Neutralization of the agent follows. Logically, one should identify the vesicant in order to select the best neutralizing substance. This takes time, and, after all, neutralization is only one step in the prevention of lesions. Household bleaching solutions (clorox or purex) of hypochlorite are effective at least against mustard (alone or mixed); pat on the contaminated skin surfaces, but do not use on the eyes.

Finally, and most important, wash carefully in a shower with plenty of lather and water. Dry without rubbing, and clothe.

To summarize self help: (1) remove the victim from the gassed area and his clothes from him, (2) wash the eyes (if very recently exposed to liquid vesicant) with water or fresh weak sodium bicarbonate solution, (3) blot off excess vesicant, (4) neutralize with household bleaching solution, and (5) shower with abundant lather and water.

The directions given above should be memorized by all civilians for their own use, and may be carried out by physicians working in decontamination stations.

Once the vesicant has injured the skin, the patient and his wounds are treated as for thermal burns. Hypochlorite is not used after erythema appears; blisters need not be opened to remove hypothetical toxic agents. No oil, neutralizing agent or tight bandage should ever be applied to affected eyes; for pain, 0.5 per cent pontocaine

(not cocaine) solution is helpful, and 1 per cent atropine should be used against miosis. Photophobia requires dark glasses. Later, boric acid ointment or sulfathiazole ophthalmic ointment may prevent or treat secondary infection.

Clay and Webster Streets.

## WOUNDS: THEIR CARE UNDER CIVILIAN DEFENSE\*

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WOUNDS obtained under conditions of bombing, explosions and gunfire vary from abrasions to severe contusions, with at times great tearing and rupture of tissues and shattering of bones. It is important, therefore, that each responsible physician be informed as to the nature of these injuries, and have a well thought-out plan how he will proceed promptly, and in an orderly manner, to render the best care possible under any given circumstance.

Wounds will, therefore, be discussed under the headings: their nature, the rôle of devitalized tissue, bacteriology and treatment.

### NATURE OF WOUNDS

Abrasions are no different than those of civil injury, except possibly for greater contamination.

Wounds of the soft tissues, due to great and sudden forces or to a crush from falling timbers or walls, have a more widely-distributed injury. There is also the chance of greater contamination due to such a high proportion of wounds being caused by secondary objects as glass, wood, masonry, etc. This leads to devitalization of tissue upon which microorganisms may live and develop, or to rupture of blood vessels with hemorrhage, furnishing thereby a nidus for infection. *The devitalization of tissue and contamination are the factors of primary importance.*

The contamination of wounds, under conditions associated with civilian defense in a war zone, forces us to consider wounds in their two main stages—that of contamination and that of infection. Contamination is that stage where the bacteria are upon the surface and not as yet proliferative; whereas infection is the stage where bacteria have invaded the tissues and proliferation is occurring.

The stage of contamination may exist up to twelve hours, but preferably should be considered up to six or eight hours. The degree of contamination varies, dependent upon the location in or out of a building, a heavily-cultivated soil, a sandy loam or paved street, the condition of the weather giving a dry warm dust or a muddy contamination of objects and clothing; the portion of the body involved, for example, the clostridia are more common about the lower extremities, especially the thigh; and the type of cleanliness

\* One of several papers in a Symposium on "Emergency Medical Service in Wartime." Papers collected by Henry Gibbons, III.  
From the Woodland Clinic.

of the clothing worn and the cleanliness of the individual, for example, the clostridia are found in a high percentage of instances to be present in woolen garments, and recent bathing gives less infection.

The stage of infection or invasion of the tissues follows that of contamination. It is dependent upon the pathogenicity and virulence of invading microorganisms; upon the degree of local trauma, that is, the amount of devitalized tissue; the presence or absence of foreign material acting as a carrier; and the resistance of the patient locally and constitutionally.

#### THE RÔLE OF DEVITALIZED TISSUE

The rôle of devitalized tissue in bacterial contamination and infection was emphasized during the last great war as it never was before. *The observance of this phenomenon is the most important aspect in the care of traumatic wounds.* A vital tissue will resist infection in varying degrees, but a piece of dead tissue serves as an excellent medium upon which all types of microorganisms, especially the clostridia, thrive. A scalpel wound has only a microscopic injury to tissue, a machine gun or rifle bullet has a comparative high velocity and a sharp and narrow striking force, and so causes little comparative tissue damage; but an irregular shell fragment with a slower velocity has a greater striking force, and causes a wider tissue damage.

The foreign body acts mainly as a vehicle of infection, but plays an important part in sustaining the infection. Bits of clothing or contaminated terrain are the most evil, and serve as carriers of infection.

The patient's resistance, both local and general, has to be reckoned with the same as in peacetime surgery. The general resistance is lowered in instances of hemorrhage, exhaustion from physical fatigue, or exposure or sepsis. The local resistance is obviously dependent upon the nourishment of the injured portion of the body and its blood supply. The greater the trauma, there results a greater contusion of tissue, a greater amount of extravasated blood, a wider dispersion into the tissues of extraneous material, and a larger area deprived of an adequate blood supply. An impoverished blood supply leads to tissue of poor vitality, an ideal culture medium, and an easy invasion by bacteria.

#### BACTERIOLOGY

The most common bacteria in civil traumatic wounds are the staphylococci and streptococci, and the spore-bearing anaerobes, *Clostridium tetani*, *Clostridium welchii* and *Clostridium septicum*. Severe traumatizing injuries of peacetime demonstrate that these anaerobes are present everywhere, in our woolen clothes, in our school yards, on walls of our buildings, and in our yards, gardens, streets and highways.

Fifteen per cent of all wounds culture streptococci in the first twelve hours, while in a few days the percentage is much larger—90 per cent.

Meleney, from a study of peacetime acute traumatic wounds, finds, in 200 such wounds, bacteria present in every instance; states no one can tell which wound will develop an infection, and that hemolytic streptococci were present in the stage of contamination in 17 per cent of instances.

The source of this infection is from the soil, from the contaminated soiled clothing, and from the unapparent slips of technique in wound dressings, and from the nasopharynx of individuals in contact with the wound. Hare stresses the last source especially, and states that 7 per cent of normal people are nasopharyngeal carriers of the important strain—hemolytic streptococcus pyogenes, (*streptococcus pyogenes* of Rosenbach.)

The anaerobic spore-bearing bacteria are found in wounds in all tissues, but it is chiefly in muscle that we see their complication—"gas gangrene"—develop. Quist divides the clinical evidence of these causative organisms into three groups: "(1) harmless saprophytes in ulcers with no pathogenicity, (2) pathogenic microorganisms producing an infection of the cellular connective tissues; gas infection of a wound or anaerobic cellulitis and, (3) as invaders of muscle-true 'gas gangrene'."

The anaerobic cellulitis or local wound manifestation is seen in subcutaneous tissue. Here occurs some devitalization of tissue, hematoma and the bacteria proliferate. There may be some extension of the products of the gas-forming microorganism to give local swelling and crepitus to some distance from the abscess; but this form of the disease, while it can go on to more extensive involvement and toxemia, usually promptly subsides with adequate drainage and removal of pabulum on which the microorganism develops.

True, "gas gangrene" is an acute, spreading gangrene, with gas formation and muscle involvement. It is not the muscle involvement alone that is essential, but an additional factor of the greatest importance is the confinement to limited space—*tension*. The disturbance of the blood supply is the important antecedent to proliferation of the infection. If a foreign body with microorganisms penetrates through a small opening and grossly injures the muscle without disturbing the overlying fat, skin and fascia, there is present the ideal condition for their development—namely, devitalized tissue, freedom from oxygen and an enclosed area for increased local tension within constricting fascial tissues, so that blood supply can be impaired to point of destruction. As a result, one sees involvement of a single muscle or of a group of muscles or an extremity as a whole. Some muscles, as the gracilis, are believed to have a limited and terminal blood supply, and are especially prone to development of "gas gangrene."

The destructive process in the muscle primarily increases intrafascial tension from gas and fluids, a strangulation of the blood supply by compression, and a probable injury to the blood vessel wall by the toxin, and therewith a resulting de-

TABLE 1.—*An Orderly Plan for Care of Traumatic Wounds.*

I.—AT DRESSING STATION	
Direct (wound)	Indirect (injured person)
A. First importance	1. Avoidance of shock.
1. Sterile dressing properly bandaged.	2. Proper hemostasis (pressure bandage over wound rather than tourniquet recommended.)
2. Immobilization.	3. Anodyne for rest.
3. Careful notation on card as to wound and complications.	4. Serum or fluids if necessary.
B. Second importance	5. As little moving as possible.
1. Washing of wound with sterile solution (ear syringe.)	6. Exclusion of relatives and friends.
2. Application of sulphonamide or antiseptic.	
C. Disposal of the injured persons.	
1. Patients with minor wounds: Dressed and advised where and when to return.	
2. Patients with major wounds: Moved within six hours carefully to base hospital.	
* * *	
II.—AT BASE HOSPITAL	
Direct (wound)	Indirect (injured person)
1. Careful investigation of nature of wound and complications, if any.	1. Orderly progress of patient with least disturbance from entry to proper place of care.
2. X-ray if necessary.	2. Complete record of data.
3. Cleansing and shaving of skin.	3. Choice of anesthesia.
4. Debridement.	4. Fluids, sera or blood transfusion as necessary.
a. Washing.	5. Avoidance or treatment for shock.
b. Careful excision.	6. Adequate sedation.
c. Change of instruments.	7. Rest from relatives and friends.
d. Suture without tension.	
5. Immobilization.	
6. Sulphonamides in wound.	
7. Serotherapy for anaerobes.	
8. Elevation and rest.	
9. As infrequent dressings as possible.	

generation of the muscle fibers. Bloodstream invasion of the microorganisms in any dangerous degree is not thought to occur until there is an overwhelming local infection. In the terminal stage a severe toxemia develops, and because of a hemolytic effect from the toxins, a jaundice frequently occurs.

#### TREATMENT

The time element, the stages of contamination and of infection respectively, have already been stressed. The endeavor must always be to care for the wound properly and adequately in the stage of contamination. That is preferably within six hours. Again, since devitalized tissue, hematoma and debris are the factors that can be removed to eliminate infection, it is important to care for these in the early stage. This means surgery. Almost every traumatic flesh wound demands surgery. This surgery is debridement, as we in America use the term, or "complete excision" as many English authors choose to say. Previous to doing a debridement, a careful history of conditions of the injury, the position of the extremity, the tissue traversed by the missile, and a careful physical examination of circulatory, nerve and muscle function, are important and should be recorded. An x-ray plate is always wise.

*Debridement* properly done is an art. "Judgment is the prime requisite." Gentleness in handling of tissues and meticulous thoroughness of the removal of all devitalized tissue and foreign material, and care to hemostasis, are the second requisite. Originally, and still in the deeper wound recesses, curved scissors were the cutting instrument most adaptable. However, if knife-blade severance into live tissue can be made, it is to be preferred. Sponging should be of the blotting, not wiping type. Flex and extend the extremity in order to reproduce the exact position as when

the wound was caused, and the path of the missile will be more easily followed. The skin is treated as conservatively as possible, but opened sufficiently always in the longitudinal, not transverse direction, to adequately expose all pockets, and recesses and devitalized tissue. The subcutaneous tissue needs removal of only the contaminated part. Fascial planes must be given special attention to prevent postoperative, valve-like action, (Pirogoff's Pouch). Therefore, elliptical incision, or adequate transverse incision of 1 to 2 cm. of the fascia, should be done in order to insure free drainage. The most important tissue, the muscle, is now attacked, and the meticulous care to this layer above all others spells success or failure. All muscle, lacking the normal red-to-pink color, failure to contract when pinched, or to bleed when cut, is excised to the point of absolute vitality. This may mean at times removal of an entire muscle, or a group of muscles or even an amputation. Trueta put it briefly and strongly when he said: "To be conservative with the limb is to be radical with the tissues," and we add especially muscle. Bone, loose and devoid of blood supply, should be removed. Soiled bone should be rongeuired away or thoroughly washed, or at least cleansed with some antiseptic, and for this ether, an excellent fat solvent, we like best. Thorough search for bone fragments, driven to some distance from the path of the missile, is necessary. All foreign material is, of course, removed.

One must never forget that a hematoma or blood clot can serve equally well, as devitalized muscle, as a nidus of infection and so, lastly, careful attention must be given to hemostasis.

Washing and washing of a wound with sterile water or salt solution or a bland antiseptic, where contaminated tissues cannot be sacrificed, is a measure of greatest value. One may use a continuous stream from an elevated reservoir or in smaller wounds a bulb "ear" syringe serves adequately.

For traumatic wounds, debridement, already discussed, is the most important aspect of treatment. Rest is second in importance, and the use of some antiseptic, acting as the name signifies or at least as an inhibitor of the growth of micro-organisms, is third. Specific antitoxin for the anaerobes is recommended.

Rest of the injured area is very important and often neglected. It is important, for movement ruptures the capillary and lymphatic thrombi by which the wound is isolated from the general circulation, and disturbs the cellular-healing processes. It must be done in such a manner, also, as to allow continuously an adequate circulation. Immobilization in bed or by splinting is often wise. Elevation of the extremity to aid blood and lymphatic circulation is beneficial.

The use of an antiseptic locally is no doubt of some value, but too heavy dependence on this should not be made. Today the sulphonamides are the popular drug, and in fresh wounds seem to have a bacteriostatic effect. A "lag period" of proliferation of bacteria, of five to six hours, is thought to occur. Therefore, in both fresh and in postoperative wounds their use is recommended.

As to whether primary suture, after debridement, is to be done, or whether the wound will be dressed open, is dependent upon the time and conditions under which the surgery is done. If the wound is cared for within six hours and can be properly debrided, and the patient can be kept under direct and continuous observation, certainly it is, as a rule, advisable and proper. If so done, suturing without tension should be stressed. However, if there is doubt as to the elimination of all infection, or the patient cannot be kept under observation, then the wound should be dressed open. It matters little if one uses sterile plain gauze, or an antiseptic and gauze, or any chemically-impregnated gauze for the wound dressing. Each physician has arrived, from experience, at his own conclusion, and one is as good as another.

Serotherapy, for the "gas gangrene" anaerobes, has proved its value, and we speak from personal observation and experience as well as from authentic reports in medical literature. A polyvalent anaerobic antitoxin from *Clostridium welchii*, 10,000 units, and *Clostridium vibron septicum*, 10,000 units, in the therapeutic dosage according to the clinical response, is of definite value, both, we believe, prophylactically as well as curatively. We recommend that where gas gangrene is anticipated, a therapeutic dose of gas gangrene antitoxin be given as prophylaxis, and be so given as to provide a continued source of supply for absorption by the body, namely, 50 per cent, intramuscularly, and 50 per cent subcutaneously. For treatment purposes it should be given in adequate dosage, for the reaction is on a quantitative basis. The need of treatment is judged by the pulse rate and patients' reactions generally, as well as by the local involvement. Some believe it of added value if injected locally near the wound; although theoretically, since it

acts through the circulation, it would not seem to be of any material consequence.

The orderly plan of care of traumatic wounds, occurring as visualized under civilian defense, is therefore recommended as follows:

A wound dressing of sterile gauze or antisepticized gauze or sulphonamide and gauze, should be applied at the primary dressing station or by the first aid man. Adequate immobilization should be obtained. The patient should be transferred to the base hospital where the main care is to be given preferably within six hours.

At the base hospital a thorough debridement should be done, with primary closure when advisable, and always immobilization to the injured area and elevation if indicated. If the wound postoperatively is to be dressed open, it should not be uncovered more often than absolutely necessary.

Such is the case of traumatic wounds; yet, as a final word in the care of an injured individual, let it be remembered always *the patient comes first, the wound second.*

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## HEAD AND BLAST INJURIES\*

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IT has been estimated that, in the bombing of cities in Great Britain, 25 per cent of all hospital entries suffered from head injuries. Therefore, the proper care for these cases cannot be overemphasized.

Two conditions are met with: those head injuries resulting from direct trauma due to flying glass, falling debris, bomb fragments, etc., and those due to blast injuries.

First aid treatment of these cases should record:

1. The presence and degree of shock.
2. The nature of the head wound.
3. The period of unconsciousness.
4. The presence of localizing signs.
5. The presence of other injuries.

All patients suffering from head injuries must be carefully observed for the early signs of shock, and the proper treatment immediately instituted.

### Scalp Wounds:

Contusions of the scalp (not associated with laceration) and hematomata require no surgical treatment. Occasionally the edge of a hematoma will be rather firm and the center soft. This is often mistaken for a depressed fracture. However, the differential diagnosis is easily made by keeping firm pressure with the index finger on the edge for about ten seconds. If it is a hematoma, the edge will quickly give way. If a depressed fracture is present, the sharp edge will remain.

\* One of several papers in a Symposium on "Emergency Medical Service in Wartime." Papers collected by Henry Gibbons, III.